Magma mixing in granite petrogenesis: Insights from geochemistry of biotite inclusions

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Many studies have demonstrated that magma mixing happened during the development of granite plutons. In particular, the compositions of biotites in granites are strongly controlled by the magmas from which they crystallized. However, the composition of matrix biotites may not reflect that of original magmas because of the effect of fractional crystallization and late- and/or post-magmatic reequilibration. Nevertheless, inclusion biotites enclosed by quartz and feldspars in granites are naturally protected by their hosts, so that their primary compositions are likely original and can potentially record the magma mixing. This is illustrated by a combined study of matrix and inclusion biotites on thin sections from Mesozoic granites in South China.

The biotites of different occurrences in the two-mica granite have no distinct difference in chemical composition. Relative to those in the biotite granites, biotites in the two-mica granite are enriched in Al_2O_3 but depleted in MgO, consistent with compositions defined by biotites from typical S-type granites. On the other hand, all biotites from the biotite granites can be categorized into different groups based on mineral paragenesis and geochemical composition. They have lower A/CNK but higher Mg#, falling between the compositional fields of biotites from S- and I-type granites. In addition, two contrasting zircons populations with the same U-Pb age occur in the biotite granite. One is bright and shows oscillating zonings in CL images, whereas the other is very dark and often overgrown on the former one. The bright zircons have higher $\delta^{18}O$ values and $(Gd/Yb)_N$, lower Hf, U, Th and Y contents than the dark zircons. An integrated interpretation of all these geochemical data indicates that mixing of two different magmas was responsible for the petrogenesis of biotite granites. Therefore, the geochemical study of biotite inclusions on the thin sections provides insights into the magma mixing in granite petrogenesis.